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<p>(21) International Application Number: PCT/US99/25614</p> <p>(22) International Filing Date: 1 November 1999 (01.11.99)</p> <p>(30) Priority Data: 60/106,674 2 November 1998 (02.11.98) US</p> <p>(71) Applicant (for all designated States except US): MAGNA MIRROR SYSTEMS INC. [US/US]; 6151 Bancroft Avenue, Alto, MI 49302 (US).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): FOOTE, Keith, D. [US/US]; 1219 Ridgebrook Court, Keweenaw, MI 49808 (US).</p> <p>(74) Agents: MILTON, Harold, W. et al.; Howard & Howard Attorneys, P.C., Suite 101, 1400 North Woodward Avenue, Bloomfield Hills, MI 48304 (US).</p>		
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<p>(54) Title: COORDINATED PIVOTING AND EXTENDING VEHICLE MIRROR</p> <div style="text-align: center;"> </div>		
<p>(57) Abstract</p> <p>A first power mechanism (20) is provided in association with a fixed support (18) and with a swingable structure (16) and pivots the swingable structure (16) relative to the fixed support (18) between an extended position and a folded position adjacent the vehicle. A second power mechanism (24) is operatively associated with a swingable structure (16) and a mirror housing (12) to move the mirror housing (12) between inner and outer extended positions. A third power mechanism (28) moves the mirror unit (14) into a desired adjusted position about horizontal and vertical axes. An electronic control controls the operation of the first power mechanism (20) and the second power mechanism (24) and the third power mechanism (28) to control the powered pivoting of swingable structure (16) and to control the generally horizontal movement of mirror housing (12) to various positions located between inner and outer limiting positions and to adjust the mirror about vertical and horizontal axes.</p>		

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COORDINATED PIVOTING AND EXTENDING VEHICLE MIRROR

BACKGROUND OF THE INVENTION

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1. Field of the Invention

The subject invention relates to a mirror assembly for attachment to the side of an automotive vehicle and which may be adjusted to various positions.

2. Description of the Prior Art

Automobiles and trucks are provided with side-mounted rear view mirrors for providing the driver with a desired field of view extending behind and along the side of the vehicle. Some vehicles, such as trucks and vehicles with trailers, have side-mounted rear view mirrors with enhanced fields of view. For example, vehicles with trailers have side-mounted rear view mirrors which extend out further than those of a typical automobile. These laterally "extended" mirrors provide the driver with a field of view which covers an area reaching behind and alongside the trailer and which is unobstructed by the trailer.

However, a driver of a vehicle carrying a large trailer will encounter various situations in which it will be necessary to adjust the position of an extended rear view mirror. For example, the angular position of the mirror is adjusted to accommodate the requirements of different drivers and to accommodate changing requirements of the same driver as the size of the truck trailer changes. A truck driver may also encounter obstacles such as tollgates, loading/unloading docks, narrow driveways, and so on. When those obstacles are encountered, the mirror's lateral position may either limit the driver's ability to maneuver around the obstacle or require the driver to manually move the mirror beforehand. It is often necessary to move the mirror to a position next adjacent the vehicle to clear obstacles. In addition, there is a need to control the movement of the mirror remotely from within the vehicle.

Various assemblies are known in the prior art for adjusting a mirror assembly between inner and outer extended positions, as exemplified in U. S. Patents 4,911,545 to Miller and 5,572,376 to Pace, while others disclose assemblies for rotating the

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mirror assembly to a folded position adjacent the vehicle, as exemplified in U. S. Patents 4,363,534 to Covert, 5,375,014 to Fujie et al and 5,703,732 to Boddy et al. However, there remains a need for a mirror assembly which can be remotely controlled by power to both be extended and retracted as well as be rotated or pivoted to a folded position adjacent the vehicle.

SUMMARY OF THE INVENTION AND ADVANTAGES

The subject invention provides a vehicle mirror assembly which can be remotely controlled by power to both be extended and retracted as well as be rotated or pivoted to a folded position adjacent the vehicle. The improved mirror assembly comprises a fixed support adapted to be mounted on a vehicle. A swingable structure is pivotally supported by and extends laterally from the fixed support to a distal end for pivotal movement about a generally upright axis between an operative position extending laterally and a folded position extending transversely to the extended position. A mirror housing is supported at the distal end of the swingable structure. A first power mechanism pivots the swingable structure about the upright axis between the operative and the folded positions. And a second power mechanism operatively interconnects the swingable structure and the mirror housing for moving the mirror housing relative to the fixed support to various positions of adjustment between inner and outer limiting positions.

Accordingly, the subject invention provides a mirror assembly that can be remotely controlled by power to be both extended and retracted as well as rotated or pivoted to a folded position adjacent the vehicle.

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BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a perspective view showing the mirror assembly in an extended position relative to a vehicle;

Fig. 2 is a perspective view of certain components of the mirror assembly in a retracted position relative to the vehicle;

5 Fig. 3 is an exploded view of the components shown in Figure 2;

Fig. 4 is a front view of the components shown in Figure 2;

Fig. 5 is a cross-sectional view taken along the line 5-5 of Fig. 4;

Fig. 6 is a perspective view of an alternative arrangement of the components shown in Figure 2;

10 Fig. 7 is an enlarged cross-sectional side view of the fixed support assembly;

Fig. 8 is a sectional view taken along the line 8-8 of Fig. 7;

Fig. 9 is a sectional view taken along the line 9-9 of Fig. 7;

Fig. 10 is an enlarged fragmentary sectional view of the pivot assembly as shown in Fig. 9;

15 Fig. 11 is a view similar to Fig. 10 showing the position of the components during the movement of the housing assembly from its operative position to the rear fold position;

Fig. 12 is a view similar to Fig. 10 showing the position of the components during the movement of the housing assembly from its operative position to the forward fold position; and

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Fig. 13 is a block diagram of a control system for controlling the operation of the various illustrated power mechanisms.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

25 Referring now to the drawings in greater detail, Fig. 1 illustrates a vehicle mirror assembly 10, which includes a mirror housing 12 supported by a swingable structure 16. A fixed support 18 is constructed and arranged to be fixedly mounted on a vehicle 19 and supports swingable structure 16 in an operative position extending laterally outwardly from the vehicle. Mirror housing 12 is provided with, among

other elements, a mirror unit 14, which serves as an exterior rear view mirror for the vehicle's driver.

A first power mechanism 20 is provided in association with the fixed support 18 and with swingable structure 16, and is arranged to enable swingable structure 16 to be pivoted with respect to fixed support 18 about a generally upright axis defined by the axis of rotation of first power mechanism 20. Swingable structure 16 may then be pivoted (1) between its operative position (extending laterally outwardly from the vehicle to allow the driver of the vehicle to utilize mirror unit 14 as an exterior rear view mirror) and a folded position in response to power operation of first power mechanism 20. The first power mechanism 20 further allows swingable structure 16 to be pivoted from its operative position in either direction in response to an unwanted impact below applied in either direction to either swingable structure 16 or to mirror housing 12. In the illustrated embodiment, the folded position of swingable structure 16 in response to power operation of first power mechanism 20 is the position at which the face of mirror unit 14 is put in close proximity or next adjacent to the vehicle; for example, almost touching the side panel of the vehicle's door (not shown).

A second power mechanism 24, as shown in Figs. 2 and 3, is operatively associated with a swingable structure 16 and mirror housing 12 to move mirror housing 12 between inner or retracted (see Fig. 2) and outer or extended (see Fig. 1) limiting positions into a desired position of adjustment upon the power operation of the second power mechanism 24. The mirror holder 26 comprises an electrically powered third power mechanism 28 operatively associated with mirror housing 12 and mirror holder 26 to move mirror unit 14 into a desired adjusted position about horizontal and vertical axes.

Fig. 2 shows main housing portion 40 in the inner limiting position with respect to upper support arm 32 and lower support arm 34. The second power mechanism 24 is shown having a cover 42, which serves as a mirror holder support for carrying mirror holder 26. The first power mechanism 20 has an upper casing 44 secured to a lower casing 46. Upper support 32 comprises an upper mating portion 48 for mating with a cylindrical drive member of first power mechanism 20 and a lower

mating portion 49 inserted within a cylindrical recess provided in a lower portion of first power mechanism 20.

Fig. 3 shows an exploded view of the components shown in Fig. 2. As illustrated in Fig. 3, the second power mechanism 24 comprises a clutch assembly 58, a motor 62, a primary shaft 64, an intermediate shaft 66, and an upper drive pinion gear 54. The upper drive pinion gear 54 is mountable on an upper shaft 56, while clutch assembly 58 is mountable within a recess 60 provided at a mid-portion of mounting structure 52. Also included are a worm 74, a shaft 76, a lower pinion 78, a worm gear 80, a spring 82, and a push nut 84.

Figs. 4 and 5 further illustrate the manner in which the various components of the second power mechanism 24 are assembled and interoperate to move mirror housing 12 between inner and outer limiting positions in relation to swingable structure 16, which comprises upper and lower support arms 32, 34 in the illustrated embodiment.

In their assembled states, upper pinion gear 54 mates with lower pinion gear 78. Lower pinion gear 78 is driven by worm gear 80 which interfaces with worm 74 of intermediate shaft 66. Intermediate shaft 66 is set into rotation by a gear 68 of primary shaft 64 interfacing with gear 72 of intermediate shaft 66. Motor worm drive shaft 63 of motor 62 interfaces with gear 70 to cause primary shaft 64 to rotate.

Fig. 5 shows a cross-section of the assembly shown in Fig. 4 taken along the line 5-5. Each of upper and lower support arms 32, 34 includes a respective lower rack 50 and upper rack 51, each of which runs longitudinally along opposing lower and upper surfaces of the support arms 32 and 34. The rack 51 interfaces with the upper pinion 54. The lower rack 50 of lower support arm 34 interfaces with the lower pinion 78. The upper pinion 54 is mounted on a shaft 56, which in the illustrated embodiment is integrally formed with mounting structure 52. Clutch assembly 58 is mounted on a shaft 76, which is provided within a recess 60 of mounting structure 52.

As described previously, in the illustrated embodiment, clutch assembly 58 includes the lower pinion 78, a worm gear 80, a spring 82, and a push nut 84. The worm gear 80 comprises an extending portion 83 and a first clutch face 81. The lower pinion 78

comprises a second clutch face 79. When clutch assembly 58 is assembled as shown in Fig. 5, first clutch face 81 comes into contact with second clutch face 79.

The upper pinion 54 is disposed so that it extends through upper gear opening 86 in a manner to allow interfacing with rack 51 of upper support arm 32. Similarly, worm gear 80 and lower pinion 78 are disposed in lower gear opening 88, and lower pinion 78 extends through lower gear opening 88 in a manner so that lower pinion 78 can interface with rack 50 of lower support arm 34.

The assembly shown in Figure 6 includes the same basic components, just arranged in a different orientation relative to one another.

Referring to Figs. 3 and 7, the illustrated vehicle mirror assembly is assembled by coupling upper mating portion 48 with cylindrical drive portion 90 of the first power mechanism 20 and concurrently inserting lower mating portion 49 into cylindrical opening 92 provided in the bottom portion of the first power mechanism 20. The upper and lower support arms 32 and 34 are then inserted into sleeves 36 and 38. The various gears and moving components are then assembled within mounting structure 52. Once the various components are mounted within mounting structure 52, the resulting assembly is then secured to an inner portion of main housing portion 40, and the upper and lower support arms 32, 34 fit within voids located behind mounting structure 52 in a manner so that racks 51, 50 of upper and lower support arms 32, 34 mesh with the upper and lower pinions 54, 78. The cover 42 of the second power mechanism 24 is then secured to the open face of mounting structure 52. Mirror holder 26 and mirror unit 14 are then to be mounted to form a resulting mirror housing 12 as shown in Fig. 1.

In operation, the first power mechanism 20 is operable to pivot swingable structure 16, comprising upper and lower support arms 32, 34 in the illustrated embodiment, between an operative position, as shown in Fig. 1, and a folded position whereby mirror unit 14 is moved toward the direction at which it is proximate to and faces the side of vehicle 19. The first power mechanism 20 is further structured and arranged to enable swingable structure 16 to be pivoted from its operative position, as shown in Fig. 1, toward either direction -- either in a counterclockwise or clockwise

direction -- in response to an unwanted impact below applied in either direction to swingable structure 16 or to mirror housing 12.

All of the power mechanisms 20, 24 and 28 are electrically operated. As illustrated in Figure 13, an electronic control system may be provided for controlling the operation of the first power mechanism 20 and the second power mechanism 24 to control the powered pivoting of swingable structure 16 and to control the generally horizontal movement of mirror housing 12 to various positions located between inner and outer limiting positions. Such a control mechanism may be configured to control the operation of the first power mechanism 20 independently of the operation of the second power mechanism 24, or the relative operations can be synchronized or otherwise dependent upon each other. Such a control system would also control the adjustment of the mirror about vertical and horizontal axes by the third power mechanism 26. The control system includes a switch or switches 94 for manually actuating each of the power mechanisms 20, 24 and 28. The control system includes a microprocessor 96 for memorizing adjusted positions of the power mechanisms 20, 24 and 28.

The second power mechanism 24 is operatively associated with swingable structure 16 and housing assembly 12 to move mirror housing 12 between an inner limiting position as shown in Fig. 2 and an outer limiting position as shown in Fig. 1 into any desired position of adjustment along the continuum between the inner and outer limiting positions.

As illustrated in Fig. 7, the first power mechanism 20 is made up of a series of components constructed and arranged to be assembled with respect to a fixed structure 100 in a predetermined sequence of downward movements into a predetermined cooperation relative to one another. The components include an inner fixed tubular member 102 and an outer fixed tubular member 104 which are fixed to fixed structures 100 and 101 concentric with the upright pivotal axis provided by the first power mechanism 20. Also provided are a reversible electric motor 110 disposed within inner tubular member 102 and a speed reducing motion transmitting assembly, generally indicated at 106, between an output shaft 108 of electric motor 110 and

swingable structure 16. Inner fixed tubular member 102 is preferably made of cast iron, steel, or similar metal so as to constitute a flux yoke for electric motor 110. The outer fixed tubular member is also preferably made of metal such as steel or the like.

5 Motion transmitting assembly 106 includes an elongated shaft 112 and a stub shaft 115 which are the first components to be assembled by downward movements into an upwardly opening bearing groove (not shown) and an upwardly opening bore (not shown) respectively formed in fixed structure 101. Motion transmitting assembly 106 also includes a drive gear 116, which, as shown, preferably is either a worm gear fixed on motor output shaft 108 and a driven gear 114 in the form of a worm wheel on
10 elongated shaft 112 disposed in meshing relation with worm gear 116. Fixed on elongated shaft 112 is a secondary drive gear 118, which also is preferably a worm gear. A secondary drive gear in the form of a worm wheel 120 is fixed on stub shaft 114 in meshing relation with secondary worm gear 118. Fixed to stub shaft 114 above gear 120 is a pinion gear 122 which meshes with a ring gear 124 having teeth 126 on
15 its interior periphery for meshing, with pinion gear 122. Ring gear 124 rests on an exterior annular flange 128 formed on the lower end of inner tubular member 102.

Speed reducing motion transmitting assembly 106 is a non-self-reversing assembly in the sense that the first worm gear set 114, 116 as well as the second worm gear set 118, 120, while capable of being driven in either direction by reversible motor
20 110, will prevent movement in either direction against that of motor 110.

The bearing groove provided for elongated shaft 112 is enlarged in the area of the first worm gear set 114, 116 and the second worm gear set 118, 120 in that elongated shaft 112 and stub shaft 115 can be moved downwardly together during assembly of one after the other. In the illustrated embodiment, electric motor 110 is
25 fixedly mounted within inner tubular member 102 which is the next component to be assembled by moving an exterior flange 128 on the lower end thereof into engagement with fixed structure 101. The inner tubular member has an L-shaped wall portion 130 in one side thereof, the horizontal lug of which is apertured to receive a bearing 132 within which the upper end of stub shaft 115 is journaled.

In order to positively prevent movement of inner tubular member 102 about its axis which is concentric to the pivotal axis, flange 128 may be suitably pinned to the fixed structure 100/101 or otherwise prevent it from turning about its axis. Inner tubular member 102 with electric motor 110 fixed thereto are assembled in such a way
5 as to bring worm gear 116 into meshing relation with worm wheel 114. Moreover, since motor 110 is fixed on fixed structure 100/101, suitable grooves (not shown) can be formed in fixed structure 101 to accommodate electrical control wires (not shown) for motor 110.

Ring gear 66 forms part of a sub-assembly which is mounted within a movable
10 tubular member 134. Movable tubular member 134 is preferably molded of a suitable plastic material. The sub-assembly including movable tubular member 134 may be regarded as a component of the first power mechanism 20.

The sub-assembly includes a spring biased indexing system, generally indicated at 136 mounted between gear 124 and movable tubular member 134. As
15 best shown in Figs. 7 and 8, indexing system 136 includes an indexing ring 138 which is keyed to the interior periphery of movable tubular member 134, as by key elements 140, so that it can move axially with respect to movable tubular member 134 but must move with movable member 134 as it turns about its vertical axis. Movable tubular member 134 includes a radially extending portion 142 and its upper midsection which
20 provides a downwardly facing surface on the interior periphery of movable tubular member 134. A coil spring 144 for biasing indexing system 136 has its upper end seated on the downwardly facing surface of portion 142 and its lower end seated on indexing ring 138. Indexing ring 138 has four annularly spaced downwardly opening recesses 146 formed therein, the arcuate extent of which are defined by opposite
25 inclined surfaces. Ring 124 has four annularly spaced indexing projections 148 which are shaped to be received in recesses 146. The sub-assembly pieces comprising coil spring 144, indexing 138, and ring gear 124, are moved respectively into the interior periphery of movable tubular member 134 and retained therein with the spring in stressed condition by a conventional C clip 150.

Movable tubular member 134 with its contained sub-assembly is assembled next by being moved downwardly over inner tubular member 102 to mesh ring gear 124 with pinion gear 122 until the lower end of movable tubular member 134 rests on fixed structure 101.

5 Outer tubular member 104 is the last component of first power mechanism 20 to be assembled. Outer tubular member 104 has an exteriorly extended flange 152 at its lower end and an interiorly directed flange 154 at its upper end. The axial extent of the outer tubular member 104 is greater than the axial extent of the movable tubular member 134 below radial portion 142 but less than the full axial extent thereof. The
10 relative axial sizes are such that, when outer tubular member 104 is assembled over movable tubular member 134 with lower flange 152 engaging fixed structure 101, annular space is left between the lower surface of upper flange 154 and the upper surface of radial portion 142. Within this annular space, a spring biased control system, generally indicated at 156, is mounted.

15 As best shown in Figs. 9-12, spring biased control system 156 includes a biasing spring 158 in the form of a wavy ring of spring steel mounted over the upper periphery of movable tubular member 134 until it is seated on the upper surface of radial portion 142. Control system 156 also includes a control ring 160 which is
20 mounted over the upper periphery of the movable tubular member until it is seated on wavy ring spring 158. Control ring 160 is keyed to the upper exterior periphery of movable tubular member 134 by key elements 162 so that it must move with movable tubular member 134 when it turns about its axis but may have axial movement against spring 158 with respect to movable tubular member 134.

25 Control ring 160 constitutes a movable control structure which is connected through motion transmitting assembly 106 and spring-biased indexing system 136 to move with swingable structure 16. Upper flange 154 of outer tubular member 104 constitutes a fixed control structure which is fixed with respect to fixed structures 100, 101.

30 Control structures 154 and 160 provide interengaging control surfaces which may take any desired form capable of achieving the functions hereinafter specified.

However, as shown, the control surfaces include a flat radially disposed inner upwardly facing annular surface 164 formed on control ring 100 and a mating flat radially disposed inner downwardly facing annular surface 166 on flange 154. It will be noted that annular control surface 164 may be divided into discrete arcuate surface portions by the recesses provided which receive key elements 162. Control ring 160 includes a pair of annularly spaced relatively large arcuate projections 168 disposed outwardly of the annular control surface 164 thereof. Projections 168 define control surfaces which for each projection 168 include a flat radially disposed upwardly facing arcuate surface 170 having an inclined surface 172 extending downwardly and arcuately away from each end thereof.

The annular flange 154 includes a pair of annularly spaced relatively small arcuate projections 174 disposed outwardly of annular control surface 166. Projections 174 define control surfaces which for each projection 174 includes a flat radially disposed downwardly facing arcuate surface 176 having an inclined surface 278 extending upwardly and arcuately away from each end thereof.

Referring again to Fig. 7, final assembly of pivot assembly is completed by extending fasteners 180 through recesses provided and lower flanged portions of fixed structure 100 and securing fasteners 180 into corresponding recesses provided within fixed structure 101.

Further details concerning the structure of first power mechanism 20 may be implemented in accordance with the description provided in commonly-assigned U.S. Patent No. 5,703,732.

While the invention has been described with reference to a preferred embodiment, it is understood that the words that have been used herein are words of description, rather than words of limitation. Changes may be made, within the purview of the appended claims, without departing from the scope and spirit of the invention in its aspects. Although the invention has been described herein in reference to particular elements, materials and embodiments, it is understood that the invention is not to be limited to the particulars disclosed herein, and that the invention

extends to all equivalent structures, methods, and uses, such as are within the scope of the appended claims.

CLAIMS

What is claimed is:

- 5 1. A vehicle mirror assembly comprising:
 a fixed support adapted to be mounted on a vehicle,
 a swingable structure pivotally supported by and extending laterally from said
fixed support to a distal end for pivotal movement about a generally upright axis
between an operative position extending laterally and a folded position extending
10 transversely to said extended position,
 a mirror housing supported at said distal end of said swingable structure,
 a first power mechanism for pivoting said swingable structure about said
upright axis between said operative and said folded positions, and
 a second power mechanism operatively interconnecting said swingable
15 structure and said mirror housing for moving said mirror housing relative to said fixed
support to various positions of adjustment between inner and outer limiting positions.
2. An assembly as set forth in claim 1 including a mirror unit, a third power
mechanism movably supporting said mirror unit in said mirror housing for adjusting
20 the position of said mirror unit relative to said mirror housing about horizontal and
vertical axes.
3. An assembly as set forth in claim 1 wherein said second power
mechanism includes a rack and pinion.
- 25 4. An assembly as set forth in claim 3 wherein said rack is disposed
on said swingable structure and said pinion is rotatably supported on said mirror
housing.

5. An assembly as set forth in claim 4 wherein said swingable structure includes a pair of parallel and spaced support arms, each of said support arms including one of said racks, a pair of said pinions rotatably supported by said mirror housing and with one pinion in meshing engagement with one of said and the other
5 pinion in meshing engagement with the other of said racks.
6. An assembly as set forth in claim 5 wherein said pinions are in meshing engagement with one another, a worm gear in driving relationship with one of said pinions and a worm in meshing engagement with said worm gear, a motor in driving
10 relationship with said worm.
7. An assembly as set forth in claim 2 an electronic control system for controlling power to said power mechanisms.
8. An assembly as set forth in claim 7 wherein said control system
15 includes a switch for actuating each of said power mechanisms.
9. An assembly as set forth in claim 7 wherein said controls system includes a microprocessor for memorizing adjusted positions of said power
20 mechanisms.
10. A vehicle mirror assembly comprising:
a housing assembly;
a mirror unit carried by said housing assembly;
25 a swingable support structure constructed and arranged to support said housing assembly thereon for generally horizontal movement between inner and outer limiting positions;
a fixed support assembly constructed and arranged to be fixedly mounted on a vehicle and to support said swingable support structure in an operative position

extending laterally outwardly from the vehicle so that said mirror unit serves as an exterior rear view mirror for the driver of the vehicle;

5 a power operated pivot assembly operatively associated with said fixed support assembly and said swingable support structure constructed and arranged to enable said swingable support structure to be pivoted with respect to said fixed support assembly about a generally upright axis (1) between an operative position thereof and a folded position with respect to the vehicle in response to a power operation of said pivot assembly and (2) from the operative position thereof in either direction in response to an unwanted impact blow applied in either direction to said swingable support structure or to said housing assembly; and

10 a power operated housing moving assembly operatively associated with said swingable support structure and said housing assembly to move said housing assembly between said inner and outer limiting positions into a desired position of adjustment upon the power operation of said moving assembly.

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11. A vehicle mirror assembly as defined in claim 10, wherein said mirror unit includes a mirror and a mirror holder for receiving and retaining said mirror therein, and a power operated mirror adjustment mechanism operatively associated with said housing assembly and said mirror holder to move said mirror into a desired
20 adjusted position about horizontal and vertical axes.

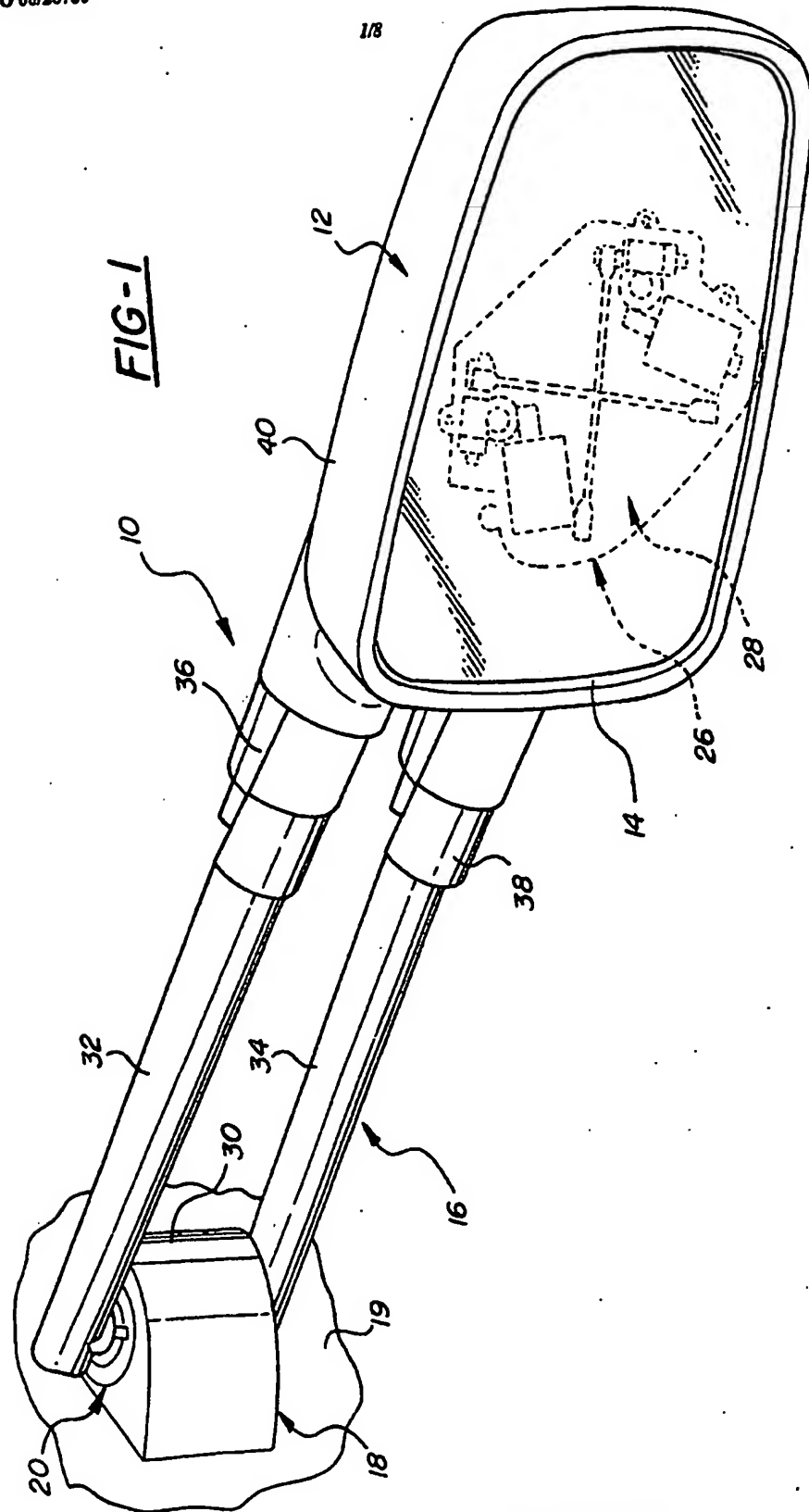


FIG-2

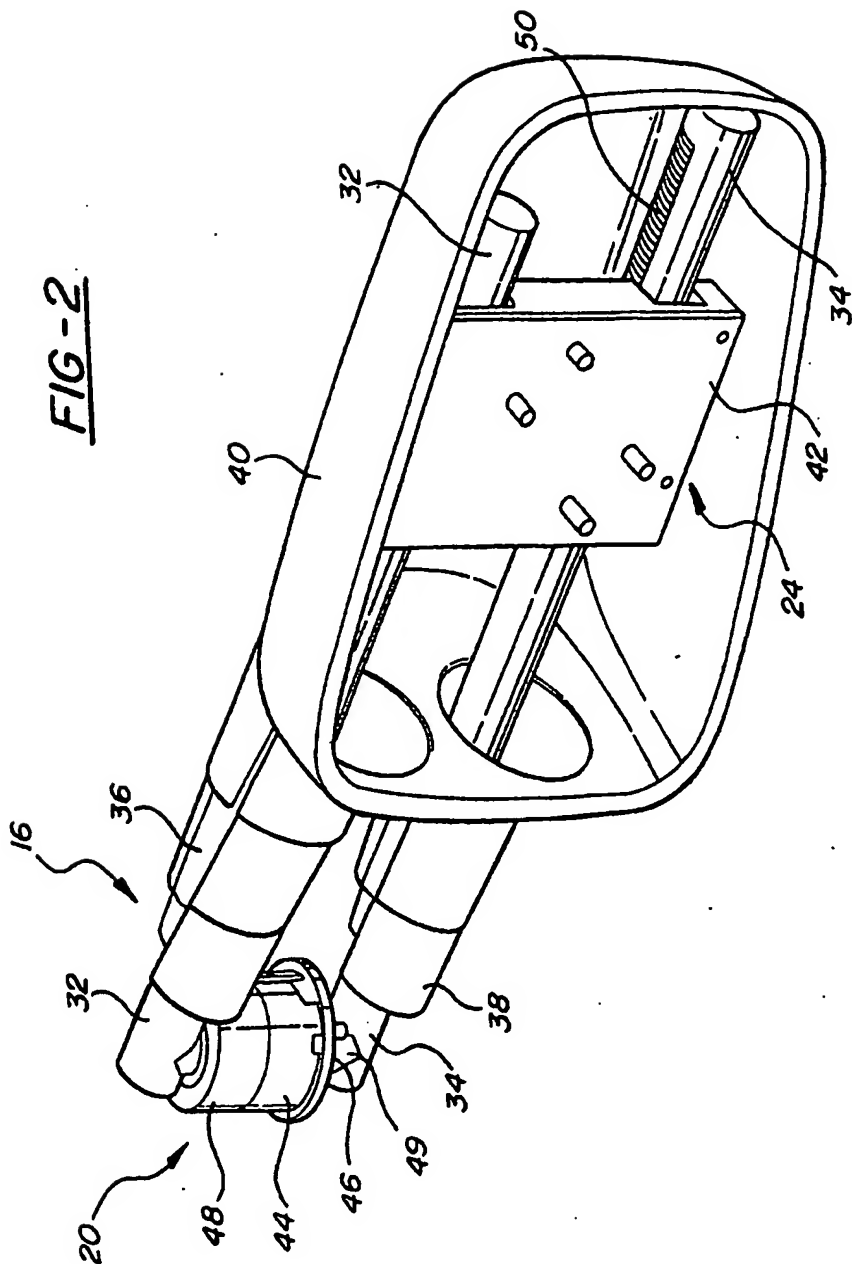
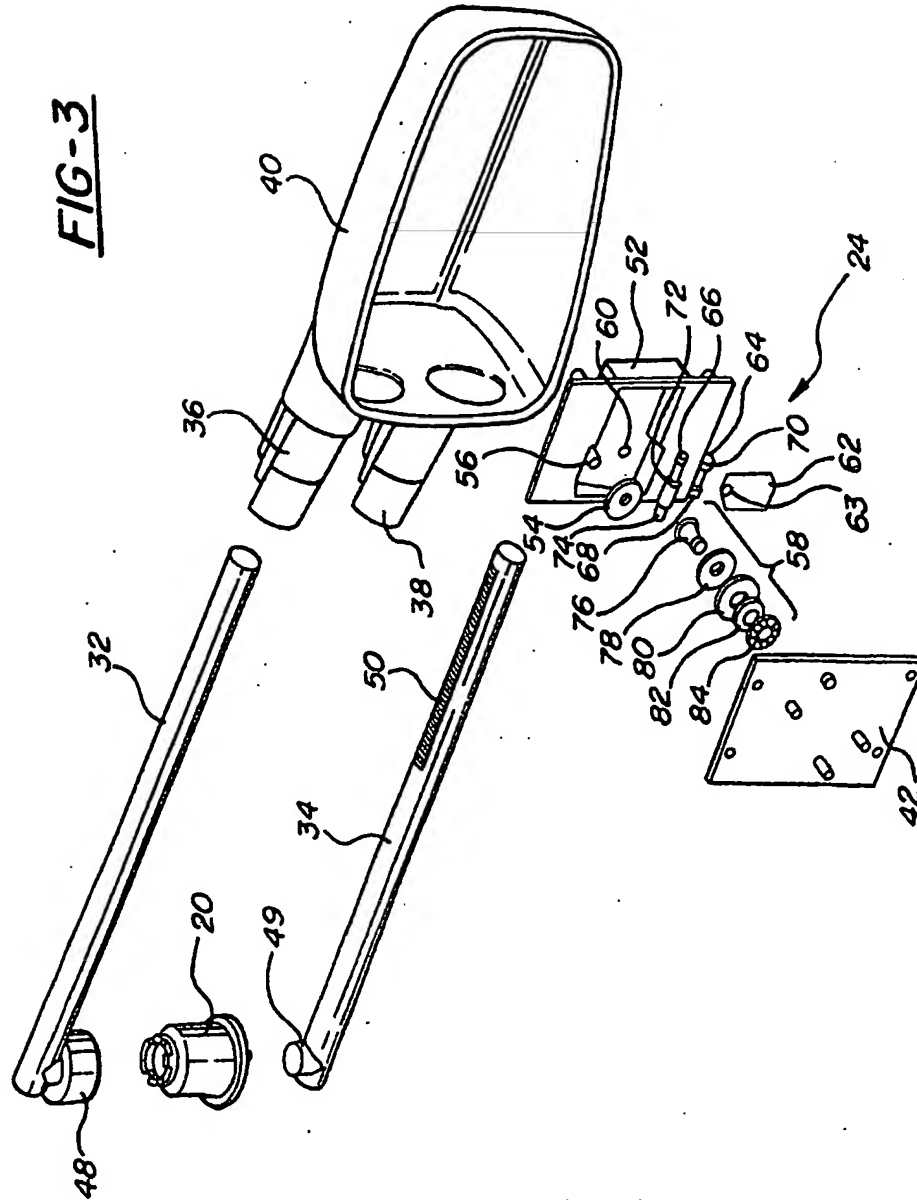


FIG-3



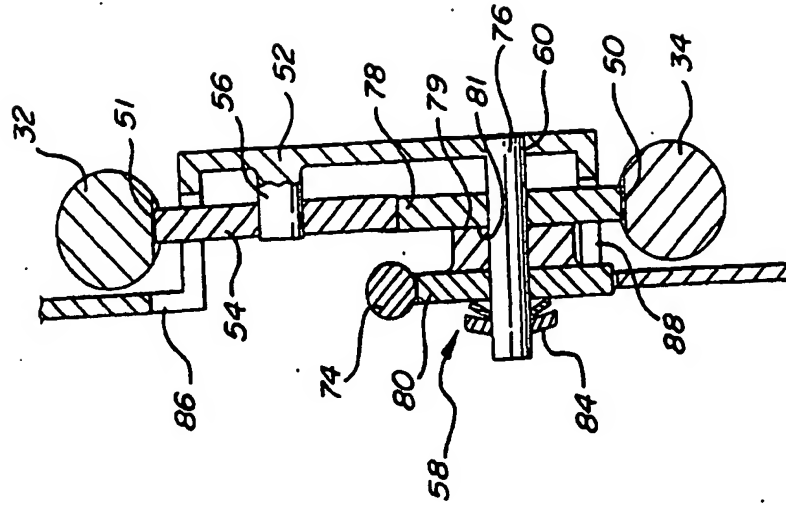


FIG-5

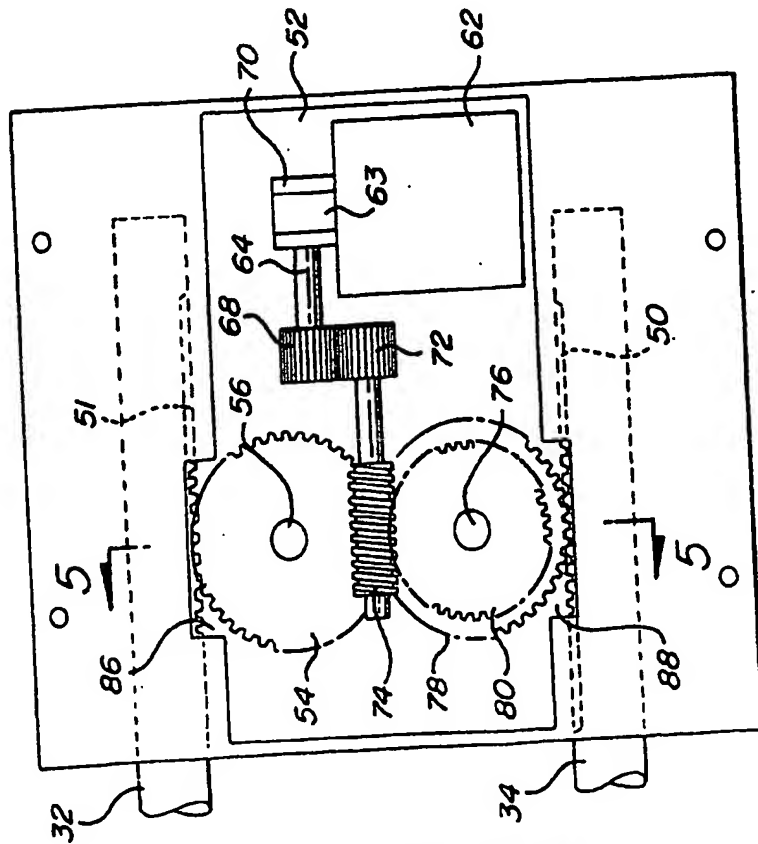
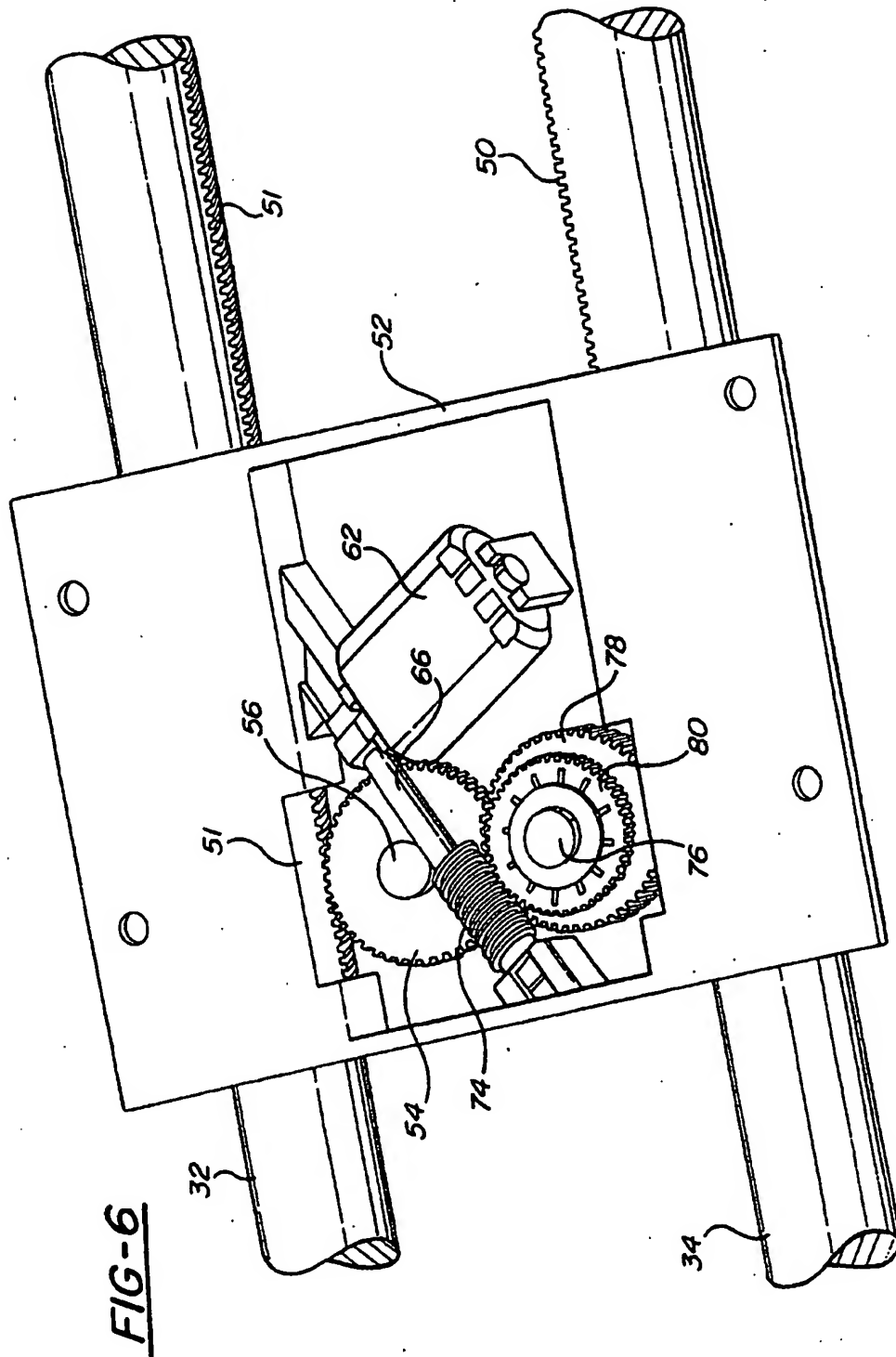
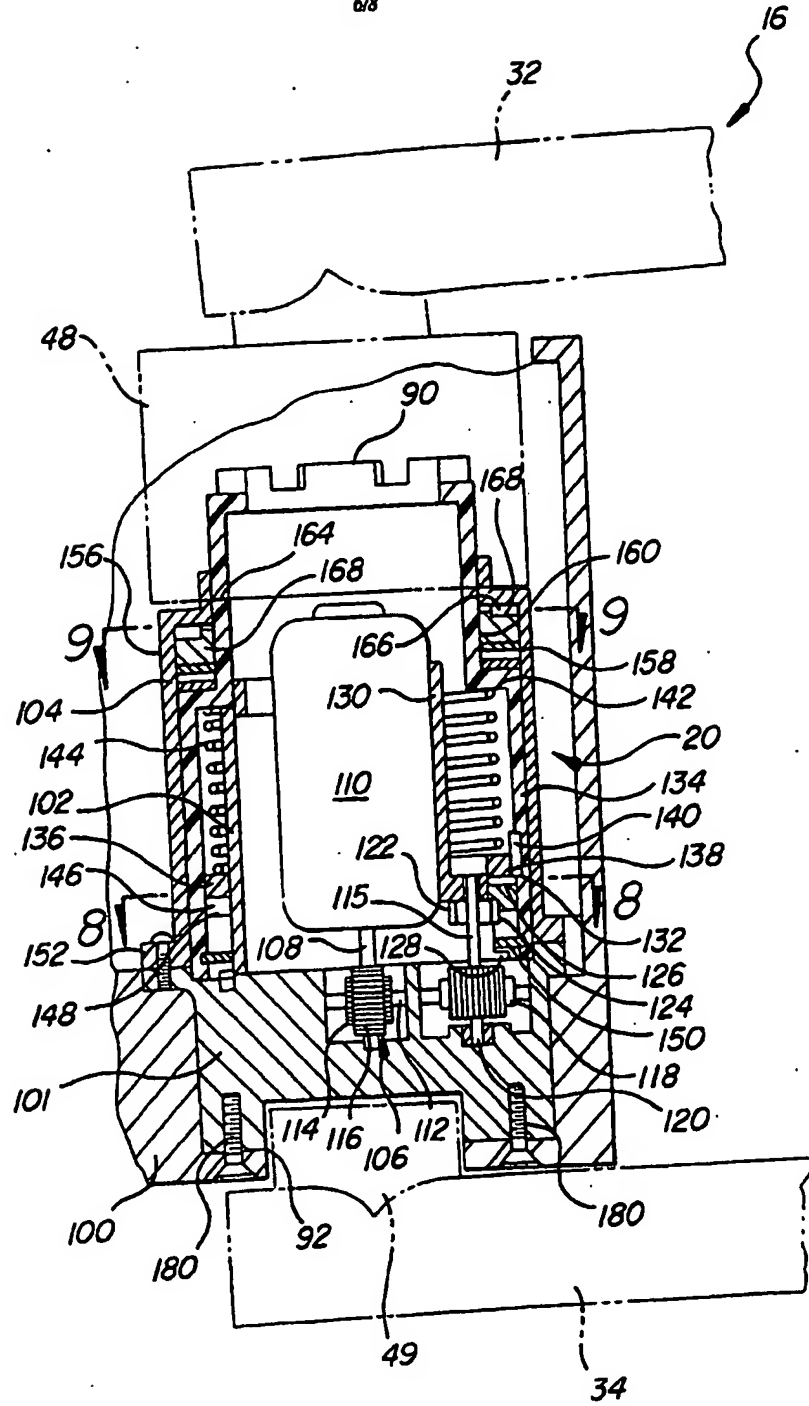
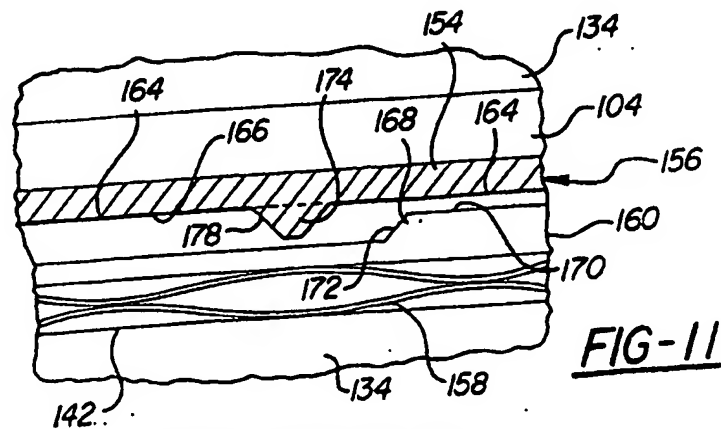
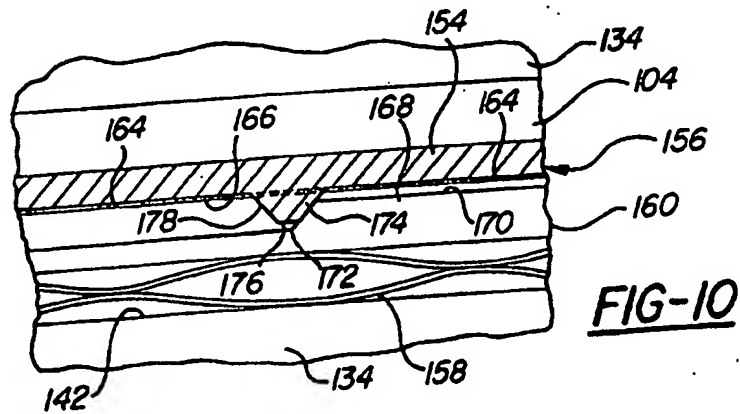
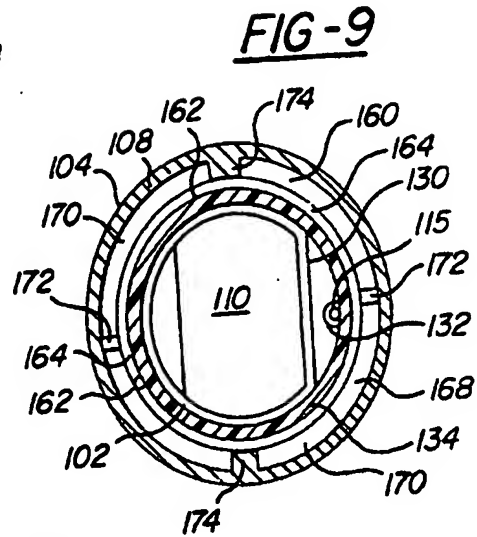
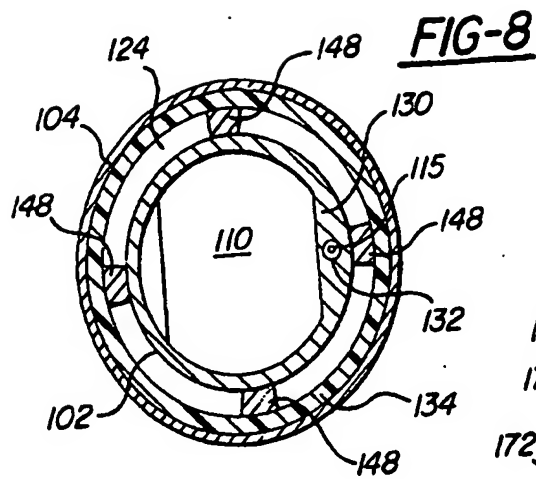


FIG-4



**FIG-7**



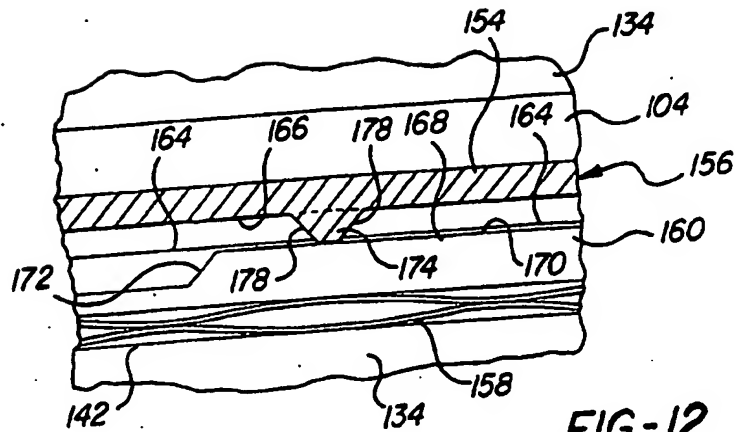


FIG-12

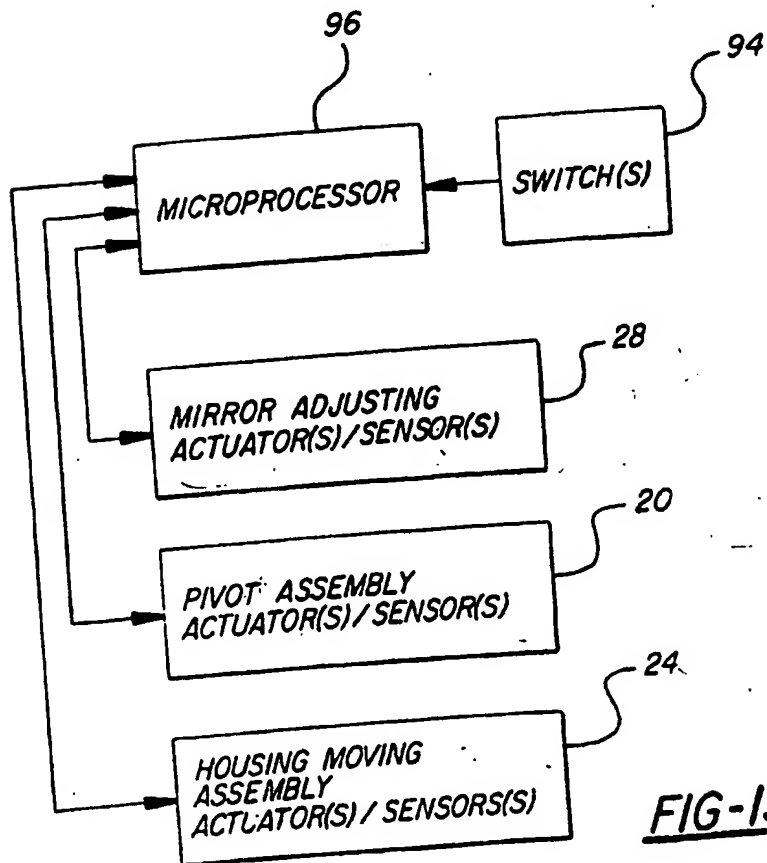


FIG-13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/25614

A. CLASSIFICATION OF SUBJECT MATTER IPC(6) : G02B 5/08, 7/182; B60R 1/06 US CL : 359/841, 872, 873, 876, 877; 248/479, 480, 485, 900 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) U.S. : 359/841, 872, 873, 876, 877, 881; 248/479, 480, 485, 900 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched NONE Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) NONE		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P — Y,P	US 5,886,838 A (KURAMOTO) 23 March 1999, (23/03/99) document.	1,2,7-11 ----- 3-4
Y,P	US 5,903,402 A (HOCK) 11 May 1999, (11/05/99) see entire document.	1-11
Y	US 5,572,376 A (PACE) 05 November 1996, (05/11/96) see entire document.	3-4
Y	US 4,558,930 A (DEEDREEK) 17 December 1985, (17/12/85) see entire document.	5-6
Y	US 4,929,878 A (HANSEN) 29 May 1990, (29/05/90) see entire document.	7-9
Y,P	US 5,969,890 A (WHITEHEAD) 19 October 1999, (19/10/99) see	1-11
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "A" document member of the same patent family		
Date of the actual completion of the international search 14 JANUARY 2000		Date of mailing of the international search report 04 FEB 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer RICKY D. SHAFER Telephone No. (703) 308-0956